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A study on the application of GIS in PCP of Rural Water Supply

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Abstract :- **The preconstruction planning (PCP) phase of any project is an individual stage that impacts the planning and execution of a construction project. In this stage, planners and contractors using their experience plan the project considering time, cost and quality constraints. In recent time, importance is being placed on using different tools like GIS in the preconstruction planning stage. In planning a water supply distribution scheme, an information system is needed that will help the construction planners to plan the project. Geographic information system is a computer based system that is used for storing, manipulating, and analysing large amount of data. This paper focuses on the water supply distribution scheme of a village Mahuli, in Maharashtra, India. In this paper study of application of GIS on one of the aspects of water supply preconstruction planning, i.e. distribution pipeline network, details and analysis in GRAM++ is done. The purpose of the study is to know the advantages of using GIS and achieving time effectiveness.**

Keywords: **- Preconstruction planning, GIS, Water supply, GRAM++**

I. INTRODUCTION

1.1 General

The Ministry of Drinking Water Supply and Sanitation has a long term strategic plan (2011-2022) for ensuring drinking water supply to all rural households. For this plan to be successful the ministry has proposed various rural water supply schemes. Whenever a new structure is to be developed, it has to become an important part of its surrounding. Hence its construction is to be planned considering the existing facilities, utilities, topography and environment. This planning comes under the pre-construction planning (PCP) stage. (Bansal, 2015)

Pre-construction planning is an individual stage, which impacts the planning and execution of a project. In this stage the planners and contractors use their experience and planning is done considering time, cost and quality constraints. In the PCP of a rural water supply scheme, the aspect of planning and detailing of the distribution network is very important so that the contractors and site engineers should not have any confusion or problem during the construction of the distribution pipeline network. Geographic information system (GIS) can be used for this purpose. (Bansal 2015)

GIS is a computer based system that is used for storing, manipulating and analysing large amount of data. It gives us a virtual environment to work in, which is as good as working on the actual site and that shall help us in knowing the exact location, existing features, and topography of the area where the distribution system is to be installed. (Mhaske, 2008)

1.2 General details of the study region

The region selected for study is the village Mahuli, in Amravati district, Maharashtra, India. The existing supply well in the village goes dry in summer and the yield is considerably decreased. Villagers have to face acute water scarcity every year. To fulfil their requirement an additional source of supply well and bore well with rising main, pumping machinery, RCC ESR, switch room and new distribution network is proposed.

II. DATA COLLECTION AND METHODOLOGY

2.1 Data collected

GIS needs two types of data viz; spatial data and attributes data. Spatial data describes the absolute and relative location of geographic features and includes maps, longitude and latitude co-ordinates. Attribute data describe the characteristics of the spatial features. These characteristics can be of quantitative or qualitative in nature. Attribute data is often in tabular form

The data collected for the study includes map of the village, as shown in Figure 2.1, from State

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Irrigation Department, Amravati, and detailed estimate of the proposed water supply scheme, drawing and details of the distribution network.

Figure 2.1: Map of Mahuli village

2.2 Methodology of work

2.2.1 Geo- Referencing

The study is conducted using GIS software GRAM++. The map of the village is first geo-referenced or geo-registered in the Map Edit mode of GRAM++. Since the village map obtained from the irrigation department didn't have co-ordinates (Latitude and Longitude), the co-ordinates were need to be obtained from Google Earth. The co-ordinates that were used for the geo-referencing of the map are as follows.

No.	Reference point	Latitude	Longitude
1	NW point	21004'02" N	77050'47" E
2.	SW point	21003'06" N	77051'13" E
3	SE point	21003'21" N	77052'26" E
4	NE point	21004'03" N	77051'57" E

The geo-referencing is done by marking the four points with their co-ordinates on the map as tick marks. The process of tick marking is done till the error is within acceptable limit. The tick marks on the map can be seen in pink colour squares and which can be seen clearly geo-referenced without the background image of the map in the following figures.

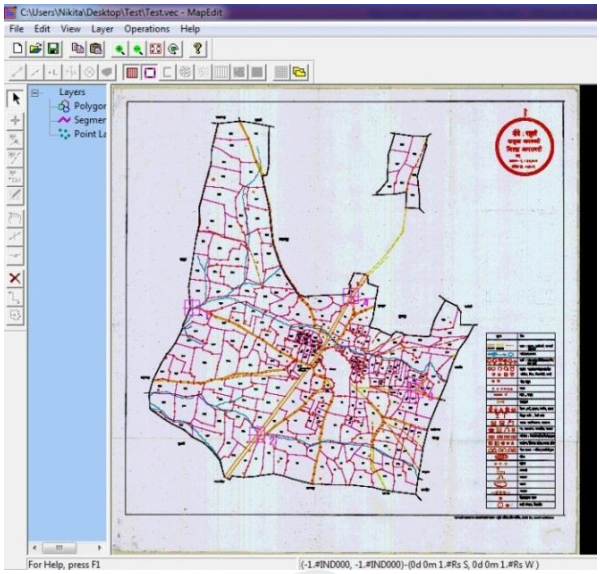

Figure 2.2: Tick marks on the map

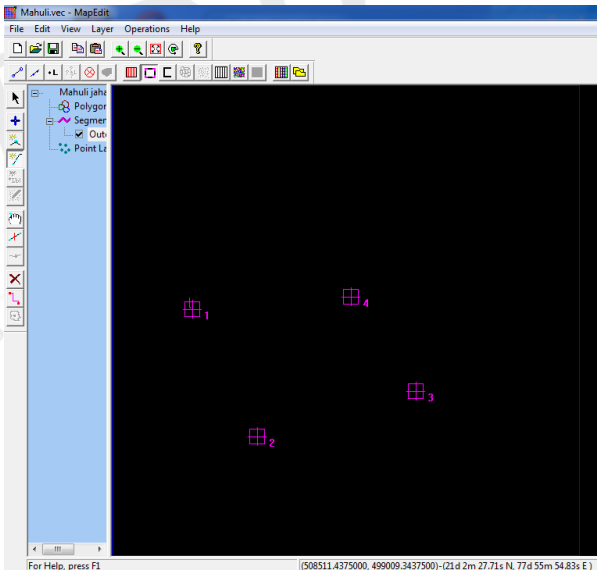

Figure 2.2: Tick marks without background image

Geo-referencing turns the map into a virtual environment, in which each point's location can be known by just putting the mouse on it. It is as good as working on the site itself.

2.2.2 Digitization

The outer and inner boundaries of the map are digitized as polygon layer in GRAM++.

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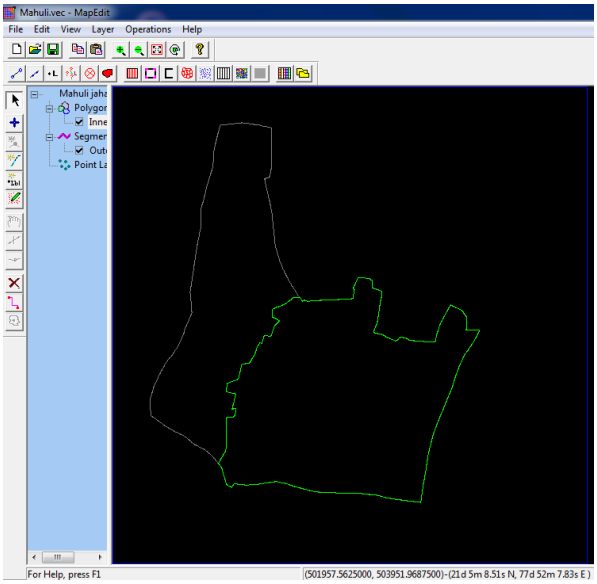

Figure 2.3: Digitized outer and inner boundaries of the study area.

Similarly, the distribution pipeline network is digitized in segment layer as shown in Figure 2.4.

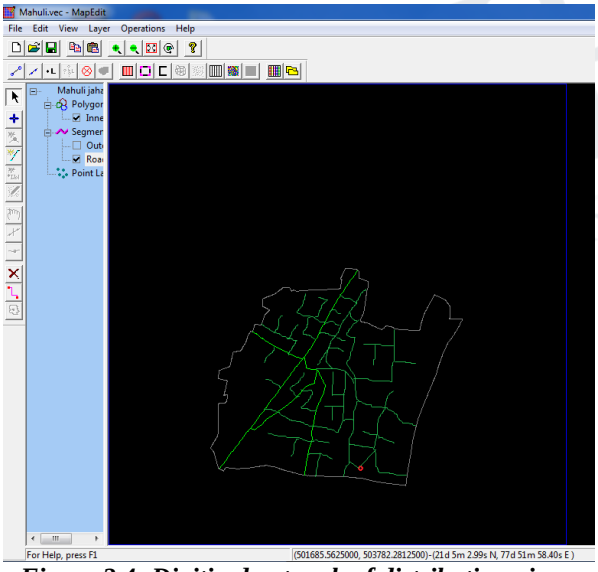

Figure 2.4: Digitized network of distribution pipes

2.2.3 Map Editing

After the digitization the layer wise cleaning of the map is carried out. The layers are checked for errors and again cleaned by removing errors. After cleaning the process of polygon formation, labelling of the polygons, and numbering of the pipes is completed.

2.2.4 Linking of Attributes

The attribute data is tabulated in Microsoft access, which consists of the pipe numbers, length or distance of the pipes, type (existing or proposed), diameter, material, class and cost of the pipes. This attribute data is then linked to the digitized map.

2.2.5 Vector Analysis

In the vector analysis mode of GRAM++, we can get any information required for the distribution network by running queries. For example, if we run a query as LENGTH OF PIPE < 200m, then we will get the list of pipes that are less than 200m long. Also we can see them highlighted on the map and their location can be known by getting the cursor on them.

III. OBSERVATIONS AND DISCUSSION

The Mahuli village water distribution network is divided into 3 zones of pipe network. The first zone consist mostly the already existing pipelines, zone 2 includes some proposed pipes long with the existing ones, and zone 3 consists of all the newly proposed pipes that are to be laid. With such an information system like GIS, it is easier to distinguish between the pipe networks of different zones. The contractors or site engineers can easily locate the pipes of different zones, and it is convenient for them to start the pipe laying work on multiple locations simultaneously depending on the human resource, machinery and equipment available with them. This will save the overall project time and the project completion period. Other than PCP, this information system will be helpful in planning of future distribution network if required. Also, if any defect is found in the distribution network, the cost analysis can be done for its rectification, as the system will be providing information of the original cost of the pipe network.

IV. CONCLUSION

Based on the study conducted, it can be concluded that GIS can be used in the PCP of a rural water supply network. The effective use of this system can be done for convenient management of construction, cost analysis, reducing overall project duration and human efforts.

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